

III.—*Observations on Trilobites, founded on a comparison of their structure with that of living Crustacea.* By W. S. MACLEAY, M.A., F.L.S., &c.\*

TRILOBITES were originally considered by Klein and others to be a particular kind of molluscous shell with three lobes. This supposition, however, was afterwards abandoned as untenable, and remained so until Latreille, in the 7th volume of the 'Annales du Muséum,' revived it and referred the trilobitic fossils to the genus *Chiton* among the *Mollusca*. Latreille founded his argument on the presumed absence of feet, and on the lateral edges of the body in several species having been sub-coriaceous. It is evident, nevertheless, that these early inhabitants of the sea could not have belonged to the sub-kingdom *Mollusca*, since they possessed compound sessile eyes and a distinct labrum. They must, therefore, be assigned to the sub-kingdom *Annulosa*, in which we may find many articulated animals which have compound eyes and a labrum very similar in structure to those of Trilobites. Having a hard, shelly, apterous tergum and inconspicuous feet, the Trilobites must have either belonged to the order *Chilognatha* among the *Ametabola*, or to the class of *Crustacea*. But all the *Chilognatha* are terrestrial animals, and the obvious geological fact is, that Trilobites resided in the sea. We must clearly therefore exclude them from the *Chilognatha* and place them among the *Crustacea*, in which class it becomes now necessary to determine their exact place.

The class of *Crustacea*, so remarkable above all other animals for the great variation of their feet, both in number and form, is divisible into two groups; those which have the eyes sessile or the *Edriophthalma* of Leach, and those which have their eyes supported on moveable peduncles or the *Podophthalma* of Leach. To the *Edriophthalma* the Trilobites clearly belong, and the question is now reduced to determine merely whether they belong to the *Amphipoda* or those existing *Crustacea* which do not undergo metamorphosis in their larva state, (among which I include not only the *Amphipoda* of La-

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Those circumstances which generally are reckoned most anomalous in the Trilobites are not in reality so very extraordinary, since they may be detected in many *Crustacea* now existing. Thus the trilobed form of the body occurs in *Serolis* and *Bopyrus*. The membranaceous or rather coriaceous margin of the body, assumed by Latreille and others to exist in Trilobites, is to be found in the female *Cymothoæ*. In these last animals also, as well as in the female *Bopyrus*, we observe the eyes to disappear as in many Trilobites. The compound eyes of *Calymene* are situated on the back of the head, but wide apart, and are composed of large facets. The same structure may be seen in the male of *Cymothoa trigonocephala*, and many other *Cymothoadae*. The absence of antennæ and the rudimentary state of the feet, both occur in *Bopyrus*, the well-known parasite of prawns. In *Spheroma* we have not only the onisciform body of *Calymene*, but also its property of rolling itself up into a ball. In *Spheroma* also we find the large convex semicircular anal segment of *Bumastus*. I think, therefore, that we can have no hesitation now in allowing the immediate affinity of the Trilobites to Isopod *Amphipoda*, and more particularly to the *Cymothoadae* and that parasitical group which is called *Epicarides* by Latreille. Indeed, if the Trilobites are once demonstrated to have possessed articulated feet, it will be difficult to remove a male *Bopyrus* from the group. Here the two eyes are placed on the back of the head wide apart. Here also there are no antennæ, no posterior lateral abdominal appendages, and besides no very distinct articulation to the sternum. If the *Bumastus* of Murchison had a body of thirteen equal segments with short crustaceous feet it would be a male *Bopyrus*, so close is the affinity! The differences between a male and female *Bopyrus*, such for in-

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stance as the presence of eyes in the former and the want of them in the latter, may also induce us to fancy that similar differences may have possibly occurred between certain male and female *Trilobita*, which from their *prima facie* difference of form are now placed in distinct genera, although they may have truly belonged to one and the same species. *Serolis* has been generally considered to come near to *Paradoxides*; but as the former has got four well-developed antennæ with crustaceous feet, and the latter none, I am inclined to believe the relation between them to be one of analogy rather than of immediate affinity.—Let us now turn to the *Entomostraca*.

Dr. Buckland, following other authors, has compared the Trilobites with the genera *Limulus* and *Branchipus*. With the latter genus, however, they obviously have no immediate affinity; although it may be well, by reference to *Branchipus*, to show that *Crustacea* can and actually do exist, with soft membranaceous feet, such as Audouin and Brongniart suspected, and Goldfuss has more lately asserted, to have been the feet of Trilobites. When, nevertheless, I take into consideration the perfect manner in which the soft body of an animal referred to me by Mr. Murchison, and by that gentleman called *Nereites Cambrensis*, has left its impression in a slaty rock, I confess I find it difficult to understand how the vestiges of legs in a Trilobite (if such legs ever really existed) should not be more evident than Goldfuss has represented them in his plates. In short, I consider the question of feet to remain still unsettled. At the same time I ought to remark, that if the Trilobites were *Crustacea*, between *Apus* and *Bopyrus*, a fact I conceive capable of demonstration, they must have been in possession of subabdominal, laminar, oviferous, appendages. Now, no traces of such appendages remain, consequently we can easily understand how feet of a similar membranaceous consistency may have disappeared in like manner. I may here observe, that Brongniart is certainly wrong in imagining that the *Ogygia Guettardi* had oval oviferous bags appendent to the abdomen like *Cyclops*, for what he considers to be such organs are more probably the membranaceous margin of the abdomen, and, besides, *Ogygia* has no immediate affinity to *Cyclops*. With reference to *Limulus*,

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its crustaceous, semilunar cephalothorax bears considerable resemblance to that of certain Trilobites, such as the genera *Ogygia*, *Asaphus*, *Paradoxides*, &c. In *Limulus*, we find reniform, compound eyes placed widely apart on the back of the head, and consisting of peculiar facets. We find, also, an indistinct trilobed structure of the superior abdominal shield. But then this is composed of a number of confluent segments, so as to appear of one piece; and, besides the two ocelli, the large crustaceous feet and cheliform antennæ throw *Limulus* far away from the Trilobites. We must, therefore, compare them with *Apus* and other *Aspidophora*; animals which, in my opinion, of all the Entomostraca, appear to come nearest to the *Trilobita*. Here we have a large clypeiform shell, rounded in front, and posteriorly emarginate, which forms a cephalothorax, on the back of which are situated three eyes. Of these the two largest are lunated, and obviously correspond to the eyes of *Trilobita*, although they are placed proportionally much nearer to each other. It is true they are simple, but so appear to have been the eyes of *Bumastus*\*. The abdomen, divided into many distinct segments, the foliaceous feet, the structure of the front of the cephalothorax, the two rudimentary antennæ, the large labrum and projecting mandibles, all show the affinity of *Apus* to the Trilobites, more particularly to *Asaphus platycephalus*, in a specimen of which from Lake Huron, Mr. C. Stokes has discovered a subquadrate labrum, which only differs from that of *Apus*, in being anteriorly deeply emarginate, while the latter is truncated. Dr. Buckland has compared this organ to that of crabs, but decapod *Crustacea* possess a very different structure, and the thing most like this labrum is to be found among the *Xiphosura*, or still better, among the *Aspidophora* of Latreille, of which group this naturalist's genus *Prosopistoma* ought more particularly to be compared with Trilobites. I am not aware, however, that any trilobite has yet occurred with vestiges of ocelli.

\* The distinction between smooth eyes and granulose eyes does not seem to be of much importance in these animals; for among the existing family of *Cymothoidæ* we not only see the males of some species with eyes and the females without them, but we observe neighbouring genera, such as *Eurydice* and *Nelocira*, the one with granulose eyes like a *Celymene*, and the other with smooth eyes like a *Bumastus*.

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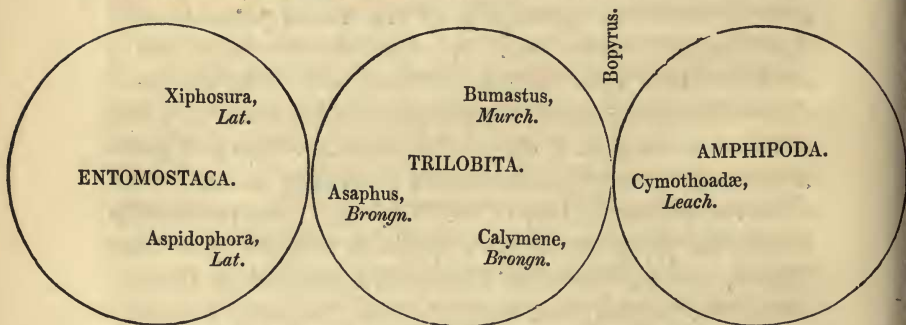
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Still there are characters which, in my opinion, distinguish Trilobites from almost all other *Crustacea*; and among these characters I would particularly mention the absence of all lateral, posterior, abdominal appendages. Excepting *Bopyrus*\* and certain *Læmodipoda*, all the *Amphipoda* possess these anal appendages, which are generally styliform, articulated and in number two. The *Læmodipoda*, however, want these appendages, because the whole abdomen in them has become evanescent, a case totally different from that of Trilobites, which, like *Bopyrus*, have a well-developed abdomen consisting of many segments. I therefore consider this deficiency of anal appendages to a well-developed abdomen, when joined with the evanescent feet and the total absence of antennæ, to be characters separating the *Trilobita* from all *Crustacea* except *Bopyrus*. The affinities of the group may be roughly expressed by the following diagram.

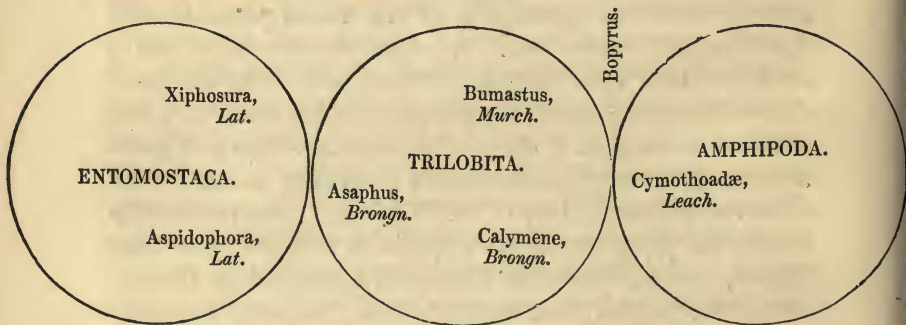


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Normal Group.	Orders.	
PODOPTHALMA, Leach. Animals having their eyes supported on moveable peduncles.	DECAPODA, Lat.	Antenniferous region of head confluent with the thorax.
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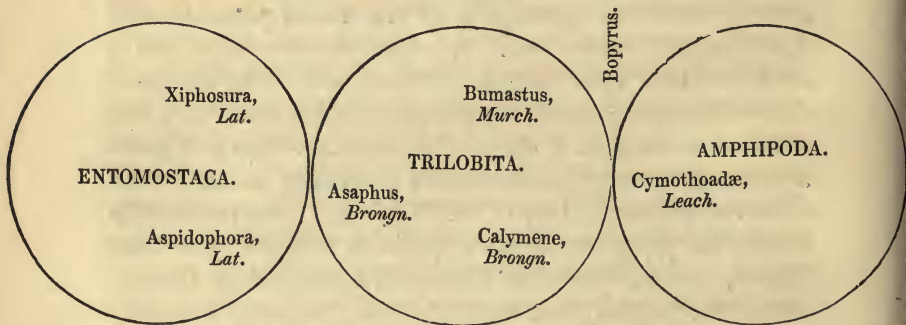


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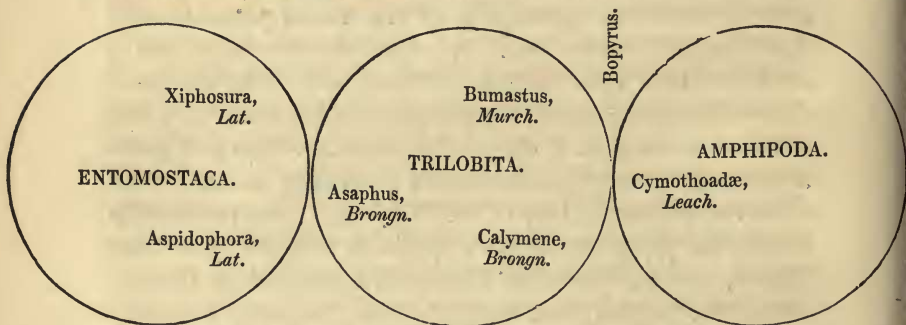


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Aberrant Group.	Orders.	
	AMPHIPODA, Lat.	Head distinct with four antennæ. Feet thick and crustaceous. Animals not undergoing metamorphosis.
EDRIOPTHALMA, Leach.	TRILOBITA, Brongn.	Head distinct without antennæ. Feet rudimentary, soft, and membranaceous.
Animals having their eyes sessile.	ENTOMOSTRACA, Lat.	Head rarely, if ever, distinct from thorax, but provided with antennæ. Feet always distinct. Animals undergoing metamorphosis.

With regard to the habits of true Trilobites, these animals have been supposed by some naturalists to be parasitical; but I conceive this hypothesis not to be very tenable, since almost all existing articulated parasites that adhere externally to other animals have strong feet, hooked at the end for that purpose. Now the Trilobites certainly had no such strong crustaceous hooks to their feet, or these hooks would have long since been detected. The close affinity of Trilobites to *Bopyrus* does not prove a parasitical mode of life, for *Sphæroma* and other *Cymothoadae* which, like Trilobites, have the power of coiling themselves up into a ball, are not parasitical, although so close in affinity to the parasitical genus *Cymothoa*. Nay, it has been said that the *Cymothoadae* and *Epicarides* do not draw their nourishment directly from the animals to which they adhere; but, on the contrary, live entirely on the animalculæ brought to them in the water by the play of the branchiæ, near which they always take their post. Still the close connexion of Trilobites with *Bopyrus*, and their feet almost null, if not entirely so, induce me to think that these animals must have been to a certain degree sedentary. The flat under surface of their bodies, and the lateral coriaceous margin of several species, which is so analogous to that of *Chiton*, make it probable that they adhered with a soft articulated underside either to rocks or fuci. They appear to have been among *Crustacea* what the *Vermes* or white-blooded worms are among *Ametabola*,—often without eyes, and always without antennæ or distinct feet. If they had feet, as Audouin and Goldfuss imagine, and, as indeed is

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IV.—*Floræ Insularum Novæ Zelandiæ Precursor; or a Specimen of the Botany of the Islands of New Zealand.* By ALLAN CUNNINGHAM, Esq.

[Continued from vol. iii. p. 319.]

TILIACEÆ, *Juss.*

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*Calyx* 4—5 phyllus. *Petala* 4. *Stamina* indefinita uniformia, *Antheris* subrotundis incumbentibus. *Stigma* denticulatum. *Capsula* sphaeroidea, echinata, 6-locularis, semi 6-valvis, polysperma.

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most probable, they must have been so small, so membranaceous, so soft, and so rudimentary, as almost to be useless to the animals for locomotion. The mouth, so analogous to that of *Apus*, makes us imagine that the Trilobites were carnivorous; and they may possibly have fed on *Acrita*, *Annelida*, or naked *Mollusca*. That they had to search for their food, and that they possessed some small power of locomotion, is to be inferred from their highly organized eyes; for no truly sessile animal is provided with sight. The *Balanus*, when it becomes sedentary, loses its eyes, as does also, in like case, the female *Coccus*. I imagine, therefore, that although the Trilobites were to a certain degree sedentary, more particularly the blind ones, they must have had some power of crawling over a flat surface; but whether they moved by rudimentary, soft, membranaceous feet, or whether it was by means of the undulation of setigerous segments, like the earth-worm, or by wrinkling the under surface of the abdomen like a *Chiton*, are questions yet to be determined. One thing, moreover, is in my opinion clear, from their longitudinally trilobed form and lateral coriaceous margin; namely, that they had the power of adhering to a flat surface, like a *Chiton*, *Bopyrus*, or *Coccus*. While thus sedentary, the hard, although thin dorsal shell, probably saved them in some degree from the attacks of fishes, just as that of *Chiton* protects such *Mollusca* from all fishes except the *Scaridæ*. The Trilobites probably, like *Ostreæ*, *Chitones*, *Cocci*, and other sedentary animals, adhered in masses one upon the other, and thus formed those conglomerations of individuals which are so remarkable in certain rocks.

IV.—*Floræ Insularum Novæ Zelandiæ Precursor; or a Specimen of the Botany of the Islands of New Zealand.* By ALLAN CUNNINGHAM, Esq.

[Continued from vol. iii. p. 319.]

TILIACEÆ, *Juss.*

ENTELEA, *R. Br., Juss.*

*Calyx* 4—5 phyllus. *Petala* 4. *Stamina* indefinita uniformia, *Antheris* subrotundis incumbentibus. *Stigma* denticulatum. *Capsula* sphaeroidea, echinata, 6-locularis, semi 6-valvis, polysperma.